PATENT
D-2550/WOD

D E S C R I P T I O N

TITLE OF THE INVENTION

SPACER FOR CENTRIFUGAL IMPELLER

INVENTORS

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Related Applications

This is a divisional application of U.S. Patent Application Serial No. 09/454,938 filed December 3, 1999, now U.S. Patent 6,290,467 B1 issued on 18 September 2001.

BACKGROUND OF THE INVENTION

This invention relates to centrifugal gas compressors and, more particularly, to an impeller and shaft assembly used in a high-speed gas compressor in a refrigeration plant or other chiller.

Centrifugal gas compressors have one or more impellers rotated in a cavity for compressing a gas, such as refrigerant vapor. The one or more impellers are mounted on a pinion shaft that is turned by a motor. In centrifugal gas compressors, it is important that the impellers and pinion shaft mounting arrangements are simple and efficient to manufacture, install and operate. In particular, overly complex attachment arrangements involving the machining of complementary grooves and threads in male and female parts pose a greater burden on highly skilled machinists, a resource that is both finite and costly. More particularly, such arrangements are more likely to be damaged during transport, installation and normal running of the compressor.

U.S. Patent No. 4,257,744 describes an impeller and shaft assembly that includes a cap screw, a Belleville washer or spring, a deformable socket machined into the rear of an

Please substitute the enclosed page 9, to cancel "CenTraVac" and substitute therefor --CENTRAVAC--.

Now refer to Figures 2 and 3, and specifically to the interior of a centrifugal compressor 12. The compressor 12 includes an impeller assembly including impellers 40, 50 mounted on a rotatable shaft 64. The compressor 12 has a gas inlet 30, a gas outlet 32, and internal passages 34 directing refrigerant gas from the inlet 30, into and through the first stage impeller 40, the second stage impeller 50, and to the outlet 32. The rear end 264 of a fastener 62 such as a bolt (or other device allowing radial rotation while providing axial clamping force) is connected to the rotatable shaft 64 to removably attach the impeller 40 to the rotatable shaft 64. Although the preferred embodiment of this invention is shown as a gear drive centrifugal compressor, the impeller assembly is generally applicable to all centrifugal compressors as well as to other compressors having an impeller 40 mounted on a terminal end 66 of a rotatable shaft such as rotatable shaft 64. Exemplary centrifugal compressors are sold under the registered trademark CENTRAVAC by The Trane Company, a Division of American Standard Inc. having a principal place of business in La Crosse, Wisconsin. Exemplary centrifugal compressors are shown in commonly assigned U.S. Patents 3,805,547 to Eber and 3,853,433 to Roberts et al., both of which are incorporated by reference herein.

Referring to FIGS.2 and 3, a first stage impeller and shaft assembly 90 including the first stage impeller 40 depicting an aspect of this invention is disclosed. The impeller 40 has an axial bore 100 through it, a front face 102 intersecting with the axial bore 100, and a rear face 104 that is adapted to fit the driving end 66 of the rotatable shaft 64. Figure 3 does not show the details of the connection between the impeller 40 and the shaft 64, which can be conventional.

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C-1 --now U.S. Patent 6,068,457 B1 issued May 30, 2000,--.

For two examples, either a conventional splined joint or the three-lobed connection described in co-pending U.S. Serial No. 09/204,867, filed by the present assignee on December 3, 1998 now U.S. Patent 6,068,457 B1 issued May 30, 2000, can be used.

The front face **102** of the impeller **40** is truncated at an end **105** and optionally has a recess **110** to accommodate a contoured spacer body **200**, a protective washer **120** and an expansor such as a spacer assembly **150**. For purposes of this application, a contoured spacer body is a device having an external surface which is aerodynamically contoured and having an internal portion acting as a spacer. The spacer assembly 150 provides a known resistance when compressed.

The protective washer **120**, preferably a hardened steel washer, has a front face **122** and a rear face **124** . The rear face **124** is seated against the front face **102** (the recess 110 if present) of the impeller **40**. The protective washer **120** has an aperture **126** registered with the axial bore **100**.

Referring to Figures **3** and **4**, the contoured spacer body **200** includes a front surface **202** and a rear surface **204**. The contoured spacer body **200** is symmetrical about an axis **206**, and the front surface **202** includes a contoured surface **210** at an angle or a curve relative to the axis **206**. The rear surface **204** includes a spring spacing abutment **220** including a washer contact surface **222** at the end of the abutment **220**. The spring spacing abutment 220 is axially dimensioned relative to the axis 206 so that the spacer assembly 150 deflects at a desired amount. The contoured spacer body **200** includes a center portion **224** having a rear recess **226** arranged in the rear surface **204** about the spring spacing abutment **220**. A central bore **230** runs through the center portion **224** symmetrical about the axis **206**. The washer contact surface **222** engages the protective washer **120**. The recess **226** provides a spring